CLAIMS

What is claimed is:

1. An electromagnetic wave vibrometer apparatus comprising:

a signal generator for generating an electromagnetic signal;

a transmitter for transmitting the signal at a vibrating object;

a receiver for receiving a reflected and/or scattered phase modulated signal from the vibrating object;

a demodulator for demodulating the received signal; and

a signal processor for analyzing the vibration waveform of the demodulated signal.

2. The apparatus of claim 1 wherein the signal is an optical signal and the apparatus further comprises a modulator for amplitude modulating the optical signal to form an amplitude modulated signal.

3. The apparatus of claim 2 wherein the optical signal is amplitude modulated with a microwave frequency signal.

4. The apparatus of claim 1 wherein the signal is a microwave signal.

5. The apparatus of claim 1 wherein the signal is a combination of optical and microwave signals.

6. The apparatus of claim 5 wherein the optical signal is modulated by the same frequency as the transmitted microwave signal.

7. The apparatus of claim 1 further comprising a laser signal source.

8. The apparatus of claim 1 further comprising an LED signal source.

9. The apparatus of claim 1 further comprising a second vibration receiver mounted with the first receiver for compensation for unwanted background or coupled vibration.

10. The apparatus of claim 9 further comprising a second vibration transmitter mounted with the first receiver for calibration of the apparatus to determine angle of reflection.

11. An apparatus for remotely measuring properties of an object comprising:

a signal generator for generating an electromagnetic signal;

a transmitter for transmitting the signal at an object;

means for vibrating the object to phase modulate the signal transmitted at the object;

a receiver for receiving a reflected and/or scattered phase modulated signal from the object;

a demodulator for demodulating the received signal; and

a signal processor for analyzing the vibration waveform of the demodulated signal.

12. The apparatus of claim 11 wherein the signal is an optical signal and the apparatus further comprises a modulator for amplitude modulating the optical signal to form an amplitude modulated signal.

13. The apparatus of claim 12 wherein the optical signal is amplitude modulated with a microwave frequency signal.

14. The apparatus of claim 11 wherein the signal is a microwave signal.

15. The apparatus of claim 11 wherein the signal is a combination of optical and microwave signals.

16. The apparatus of claim 15 wherein the optical signal is modulated by the same frequency as the transmitted microwave signal.

17. The apparatus of claim 11 further comprising a laser signal source.

18. The apparatus of claim 11 further comprising an LED signal source.

19. The apparatus of claim 11 further comprising a second vibration receiver mounted with the first receiver for compensation for unwanted background or coupled vibration.

20. The apparatus of claim 19 further comprising a second vibration transmitter mounted with the first receiver for calibration of the apparatus to determine angle of reflection.

21. A method of remotely measuring vibration comprising:

generating an electromagnetic signal;

transmitting the signal at a vibrating object;

receiving reflected and scattered phase modulated signal from the vibrating object;

demodulating the reflected phase modulated signal; and

analyzing the demodulated signal.

22. The method of claim 21 wherein the signal is an optical signal and the method further comprises modulating the signal before transmitting the signal.

23. The method of claim 22 wherein the step of modulating the signal comprises amplitude modulation.

24. The method of claim 21 wherein the signal comprises a microwave signal.

25. The method of claim 21 wherein the signal comprises a combination of microwave and optical signals.

26. The apparatus of claim 25 wherein the optical signal is modulated by the same frequency as the transmitted microwave signal.

27. The method of claim 21 wherein the signal is generated by a laser or a low coherent laser diode.

28. The method of claim 21 wherein the signal is generated by an LED.

29. The method of claim 21 further comprising compensating for vibration errors by determining vibration displacements of the transmitter and receiver.

30. The method of claim 29 further comprising providing a second vibration receiver mounted with the first receiver for compensating for unwanted background or coupled vibration.

31. The method of claim 30 further comprising providing a second vibration transmitter mounted with the first receiver for calibrating of the vibrometer to determine angle of reflection.

32. A method for remotely determining properties of an object comprising:

transmitting a signal at an object:

vibrating the object;

receiving the reflected and scattered phase modulated signals from the vibrating object; and

processing the phase modulated signal to extract information about the properties of the object.

33. The method of claim 32 wherein the signal is an optical signal and the method further comprises modulating the signal before transmitting the signal.

34. The method of claim 33 wherein the step of modulating the signal comprises

amplitude modulation.

35. The method of claim 32 wherein the signal comprises a microwave signal.

36. The method of claim 32 wherein the signal comprises a combination of microwave and optical signals.

37. The apparatus of claim 32 wherein the optical signal is modulated by the same frequency as the transmitted microwave signal.

38. The method of claim 32 wherein the signal is generated by a laser or a low coherent laser diode.

39. The method of claim 32 wherein the signal is generated by an LED.

40. The method of claim 32 wherein the generated signal is split into first and second signals and the second signal is transmitted to a demodulator for comparing the second signal with the received reflected signal.

41. The method of claim 32 further comprising compensating for vibration errors by determining vibration displacements of the transmitter and receiver.

42. The method of claim 41 further comprising providing a second vibration receiver mounted with the first receiver for compensating for unwanted background or coupled vibration.

43. The method of claim 42 further comprising providing a second vibration transmitter mounted with the first receiver for calibrating of the vibrometer to determine angle of reflection.